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Are We Producing Narci-nials? An Adaptive Agent Model for Parental Influence

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Abstract. Parental influence plays an important role in the mental development of a child. In the early years of childhood, a parent acts as a role model to a child, so most of the children try to mimic their parents. In our work, we address a complex network model of a child who is influenced by a narcissistic parent from his/her childhood to his/her adolescence. This concept of mimicking in childhood is represented by social contagion. Later on, he/she can learn to develop his/her own personality based on experience and learning. This model can be used to predict the influence of a parent over the personality of a child.

Keywords: Narcissism · Parental influence · Reified architecture · Social contagion

1 Introduction

Parents' behavior contributes significantly to the development of their children's mental and psychological health, as they act as a role model to them [1]. During their childhood, copying is considered to be an important part of learning and, thus depicts the behaviors and personality of a child [1, 2]. Parental narcissism can also be responsible for narcissism in a child, as (s)he unconsciously internalizes it [3].

Literature indicates that the self-esteem of a child is positively correlated with approval/disapproval from parents [4]. However, overvaluation and following a narcissistic parent often result in narcissism, where a child develops a feeling of superiority over others [5]. In the field of computational modeling narcissism has been addressed along with possible reactions to positive/negative feedbacks [6]. However, it would be interesting to see how a narcissistic parent influences his/her child, while being happy.

Causal modeling is a field of artificial intelligence, which is used to address many biological, cognitive and social phenomena [7, 8]. It is used to study the real-world processes, and entails how an event can influence the behavior of a process. For example, how a parent feeling happy or sad can influence behavior of a child, and how his/her behavior can vary if a parent is narcissistic. Here, we aim to answer a) which processes can be responsible to develop a narcissistic personality in children and, b) how maturity can change this behavior, while using social media. The obtained computational model can be used to predict narcissism and its progression in a child, especially when this child is interacting over social media. Prediction of such behaviors

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can be helpful to detect narcissistic traits in a child [5], and can be used as a basis to cope with narcissism.

This paper is organized in five sections. Section 2 discusses the related work, Sect. 3 discusses the designed network model of the child based on the approach described in [8]. Section 4 addresses the simulation experiments and Sect. 5 concludes the paper.

2 Related Work

Much literature is available to address the mental and social development of children and adolescents under parental influence [2, 9, 10]. This section covers the development of a child of a narcissistic parent using three types of input: psychological, social and neurological sciences.

Psychologically and socially, a clear distinction is to be made between narcissism and self-esteem. The former is related to self-love/self-rewarding behavior, while the latter is related to the sense of self-worth [11] without feeling superiority. An outcome of parental warmth results in high esteem, however overvaluation can result a narcissistic child [9]. The self-inflation hypothesis states that when a child is overly admired, this leads him or her to be a narcissist, as children use this kind of feedback to form a view of themselves, like they believe others look at them [5]. Using social media at childhood is not a new thing, and can be used for entertainment or for self-expression [12]. A reason to use social media can be novelty, which can be related to: technology, remaining active over social media/trend setting, or the content itself [13]. Through literature, it has been shown that children use copying behavior from their surrounding people [1]. Another study indicates, that children mimic the grandiosity of their mothers by internalizing experiences based on mutual interactions. This internalization helps to form the image of oneself, which in this way is an unconscious projection of early care-givers (e.g., parents) [3]. Another study indicates that narcissism may get less with maturity of a child [14].

From a neurological perspective, parental influence is addressed from early age of a child [15]. Variations in the brain have been explored in different studies, which indicate changes in the brain volume or the grey matter that are a result of parent-child interactions [15, 16]. Another study showed that the child and mother have greater perceptual similarity for a situation [17]. For narcissism and self-exhibition different brain regions like Prefrontal Cortex (PFC), Anterior Cingulate Cortex (ACC), insula and temporal lobe are enhanced along with striatum during self-rewarding behavior [18–20].

Temporal-causal modelling is a branch of causal modeling is used to address different biological, social, behavioral, cognitive, affective and many other types of processes in an integrative manner. For example, while being in a social environment, one person can influence another person. From a social science view, this is called 'social contagion', through which behavior of a person influences another person's behavior. However multiple inputs can affect this behavior [21], along with the social contagion. Previously, a narcissist's vulnerability was modeled, through a reified network architecture. This indicates how different brain parts are causally related to each other to dynamically generate a reaction over a positive or negative online feedback [6]. However, the parental influence of a narcissist parent, was not addressed, but should be addressed to detect and to provide support to a narcissistic child [9].

3 The Designed Complex Network Model

This section presents a multilevel mental network model of a child who is influenced by his/her parent based on the literature discussed in Sect. 2. The architecture is based on the reified architecture approach and consists of three levels, each of which signifies a special role related to the behavior of the model [8]. For instance, level I indicates the base model, level II and III address the adaptive behavior of the model. Here Fig. 1, depicts the graphical representation of one of the agents, i.e. a child and, Table 1 and 2 provide the information of each level. For the second agent (on left), i.e. the model of a narcissistic parent, who influences his/her child, please see here [6].

3.1 Level I: Base Level

The designed network model is a conceptual representation of a real-world scenario. For example, consider a scenario "*He likes ice-cream, so he buys ice-cream*", this can be represented by a causal relationship between two states *X* ('*like ice-cream*') and *Y* ('*buy ice-cream*'), i.e., $X \rightarrow Y$. The *activation level* of *Y* is determined by the *impact* of *X* on *Y* at a certain *time*. A temporal-causal network model is identified by three types of characteristics of a network:

Connectivity:
Connection weights $\boldsymbol{\omega}_{X,Y}$ indicate how strong state *X* influences state *Y*.
Aggregation of Multiple Impacts:
Combination functions $\mathbf{c}_{\boldsymbol{Y}}(..)$determine the aggregated causal impact from the single impacts $\boldsymbol{\omega}_{Xi,Y}X_i(t)$ of all incoming states (X_i : i = 1 to N) on state *Y*.
Timing:
Speed factors $\boldsymbol{\eta}_Y$ indicate the speed of causal influence over state *Y*.

Level I shows the base level of the model of a child, which consist of 26 states. Here, three types of arrows can be observed. Black arrows indicate a positive connection between two states with connection weights between [0,1]. Purple arrows indicate suppression (negative $\boldsymbol{\omega}_{X,\mathrm{Y}}$) from one state to another, which is indicated by a negative sign with magnitude of connection weight in [−1, 0]. Green arrows represent adaptive connections between two states, which can change/learn over the time and will be discussed in detail in Sect. 3.2.

According to the literature addressed in Sect. 2, parents influence a child's behavior. Here, we address that how a narcissist influences his/her child when he is happy. The parent is shown on the left with only one state es_{happy} without complex details of the model, for details of that part we refer to [6]. So es_{happy} (narcissistic parent is happy) acts the only input received from the parent. Upon getting the stimulus, the sensory (ss_h) and representation (srs_h) states get actived and, the child tries to act in the same way as his/her parent. An example can be '*being in a crowd and feel good to be noticed*'. This makes him believe positive (child belief state cbs) about him/herself and (s)he self exhibits. Moreover, he/she realize that the parent is factual. Thus, (s)he learns to replicate the parent's reward seeking behavior (cfs_{love}; $c_{striatutm}$; c_{insula}; cfs_{reward}) in a conscious way (cPFC). This process models social contagion behavior.

However, it is quite possible that he/she doesn't agree with his/her parent with the passage of time. An example, can be that he/she may realizes with age ($eval_h$) that the parent is an attention-seeker or a narcissist, so (s)he may react in another way. Here, learning is shown by the adaptive link (green). An example can be '*he can sit at a calm place* (cps_{act}; ces_{act}) *where he remains unnoticed*', this action will give him or her inner satisfaction (fs_{sat}). This kind of behavior can be learned from experiences (hipp). This also reflects that with age/maturity, narcissism might fade away.

Table 1. Categorical explanation of states of the base model (Level I).

Categories		References
Stimulus states:		*Stimulus is sensed and leads to representation:* [21]
es_{happy}	Input from a narcissistic parent	
ws_s	Using social media	
Social contagion related states:		*"yet familiarity.. infants copy more actions of a familiar, compared to an unfamiliar model"*[1] *"mothers show high self– child overlap in perceptual similarity in the FFA regardless of their relationship quality with their child"* [17]
cbs	Belief state of child	
	cstriatum	
	Striatum: Brain part of child	
cPFC	Prefrontal Cortex: Brain part	
$csfs_{love}$	Feeling of self-love (Amygdala)	
cfs_{reward}	Feeling of self-reward (Amygdala)	
ces_{happy}	Execution state of happiness	*"adolescents was associated with neural activation in social brain regions required to put oneself in another's shoes"* [17]
Non-narcissistic related states:		
$eval_h$	Evaluation state for analyzing behaviors	
cps_{act}	Preparation state	
ces_{act}	Execution state	
hipp	Hippocampus: Brain part for memories	
fs_{sat}	Feeling of satisfaction	

(*continued*)

Table 1. (*continued*)

Categories		References
Social media related states:		*"Emotion then facilitates behavior that is in line with our concerns"* [22]
ws_s	Input from social media (e.g. a post)	
ss_s	Sensory state	
srs_s	Representation state	
$eval_s$	Evaluation of the input, based on belief	
os	Ownership state	
ps_{share}	Preparation state	
es_{share}	Execution state	
exp	Experience	
fs_i	Feeling states *i* = novelty (nov)/emotion (em) / urge	

Another stimulus to the child is when (s)he starts using the social media. This is represented by the world state (ws_s), respective sensory (ss_s) and representation state (srs_s). A child can share the content after evaluating ($eval_s$) it, based on three attributes: novelty (fs_{nov}), some emotional value attached to it (fs_{em}),and the urge to share (fs_{urge}) it. This can be earned by experience (exp) and learning. Moreover, his action is self-attributed (ownership state: os). Here the control state (ccs) controls the sharing phenomena based upon beliefs influenced by his/her parent. Similar to his/her parent, when the child starts using social media, he/she might get pleasure by exhibiting himself.

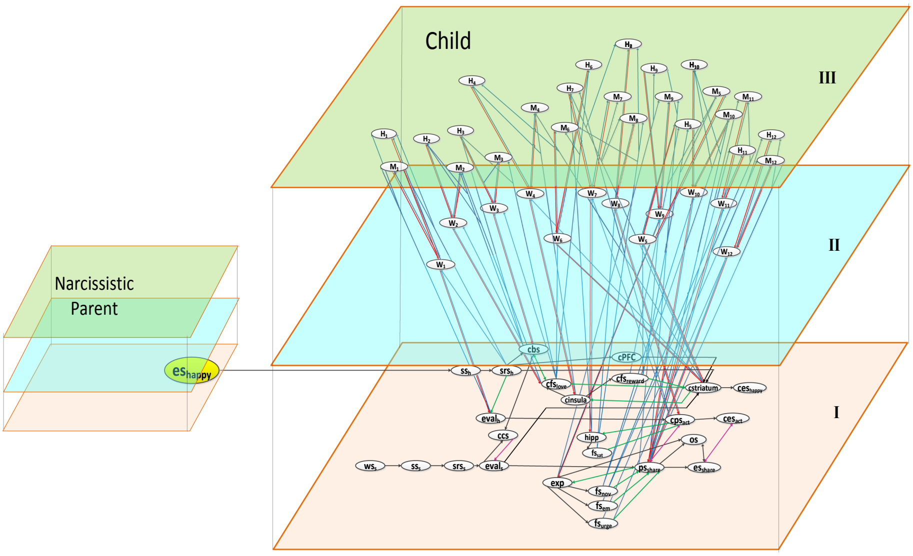

Fig. 1. Multi-leveled reified network architecture for a child.

3.2 Level II: First-Order Adaptation

This level addresses the adaptation principle related to 'Hebbian Learning', which is represented at Level II, by twelve W-states W_i (where $i = 1$ to 12 representing the weights of the twelve green colored connections at Level I). The dynamics of these W-states shows the learning of these connections in terms of persistence and time addressed in Sect. 3.3. The involved states at level I act as presynaptic and postsynaptic states for a W-state. For illustration, consider W_{10} (or $W_{fs_{nov}, ps_{share}}$), for fs_{nov} and ps_{share} as presynaptic and postsynaptic states for connection $fs_{nov} \rightarrow ps_{share}$. This indicates that the strength of a connection $fs_{nov} \rightarrow ps_{share}$ can change over time according to W_{10}. Table 2 enlist the W-states for the twelve adaptive connections. See [8] for more details about modeling the hebbian learning principle.

3.3 Level III: Second-Order Adaptation

The adaptation principles can themselves change over time as well, which is represented by the notion of meta-plasticity exhibited at this level III [8]. Here, 24 meta-plasticity-related states are represented by M_i and H_i (Table 2). The former is related to the persistence while the latter is related to the speed of learning of the states W_i (where $i = 1$ to 12). These states have upward (blue) arrows from the presynaptic, postsynaptic and relevant W-states. The downward causal connections (red) from H- and M-states influence the related W-states. To illustrate it further, consider M_{10} and H_{10}, they have upward arrows from the state fs_{nov} (presynaptic), ps_{share} (postsynaptic) and W_{10} state ($W_{fs_{nov}}, ps_{share}$) for connection $fs_{nov} \rightarrow ps_{share}$. For the downward connection, states M_{10} and H_{10} have downward arrows to W_{10}, to control its persistence and speed, respectively. A low value of H_{10} makes a low speed of learning of W_{10} and can be used (together with M_{10}) to control the learning and persistence of the concerning base level connection ([8], p. 110).

Table 2. Explanation of states in level II and III.

States per Level		References
Level II (Plasticity/Hebbian learning for Omega states):		*First-order adaptation level for plasticity by Hebbian learning* [8, 21]
W_1: W_{srs_h}, $eval_h$	for $srs_h \rightarrow eval_h$	
W_2: W_{bs}, fs_{love}	for cbs $\rightarrow$ cfs_{love}	
W_3: $W_{fs_{love}}$, bs	for cfs_{love} $\rightarrow$ cbs	
W_4: $W_{striatum,insula}$	for cstraitum $\rightarrow$ cinsula	
W_5: $W_{fs_{reward}}$, striatum	for cfs_{reward} $\rightarrow$ striatum	
W_6: $W_{fs_{love}}$, striatum	for cfs_{love} $\rightarrow$ striatum	
W_7: $W_{ps_{sat}}$, hipp	for ps_{sat} $\rightarrow$ hipp	
W_8: $W_{fs_{sat}}$, ps_{act}	for fs_{sat} $\rightarrow$ cps_{act}	
W_9: $W_{ps_{share}}$, exp	for ps_{share} $\rightarrow$ exp	
W_{10}: $W_{fs_{nov}}$, ps_{share}	for fs_{nov} $\rightarrow$ ps_{share}	

(*continued*)

Table 2. (*continued*)

States per Level		References
W_{11}: $W_{fs_{em}, ps_{share}}$	for $fs_{em} \rightarrow ps_{share}$	
W_{12}: $W_{urge, ps_{share}}$	for urge $\rightarrow ps_{share}$	
Level III (Meta-Plasticity/Learning rate and persistence):		*Second-order adaptation level for meta-plasticity to control the Hebbian learning* [8]
M_i: Persistence for $i = W_j$: j = 1,…,12		
H_i: Learning rate for $i = W_j$: j = 1,…,12		

We used two type of inputs for the model of a child. One is received from the parent: es_{happy} is equal to the value obtained from his/her parent. As we address here the influence of a happy parent, the value ranges between 0.8–1. The second input is when the child uses social media, which is indicated by ws_s = 1 and 0 otherwise. Three combination functions were used to aggregate causal impact:

a) States ss_h, srs_h, ces_{happy}, fs_{sat}, ss_s, srs_s used the Euclidian function.

$$\mathbf{eucl}_{n,\lambda}(V_1, \ldots, V_k) = \sqrt[n]{(V_1^n + \ldots + V_k^n)/\lambda}$$

b) For 43 states (cbs; cPFC; cfs_{love}; cfs_{reward}; cinsula; cstiatum; $eval_h$; ps_{act}; es_{act}; hipp; ccs; $eval_s$; exp; fs_{novel}; fs_{em}; $fs_{urge;}$ os; ps_{share}; e_{share}; H_i; M_i i = 1–12), the function **alogistic** (with positive steepness $\boldsymbol{\sigma}$ and threshold $\boldsymbol{\tau} < 1$) was used:

$$\mathbf{alogistic}_{\boldsymbol{\sigma},\boldsymbol{\tau}}(V_1, \ldots, V_k) = \left[\frac{1}{1 + e^{-\boldsymbol{\sigma}(V_1 + \ldots + V_k - \boldsymbol{\tau})}} - \frac{1}{1 + e^{\boldsymbol{\sigma}\boldsymbol{\tau}})}\right](1 + e^{-\boldsymbol{\sigma}\boldsymbol{\tau}})$$

where each V_i is the single impact computed by the product of weight and state value: $\omega_{X,Y} X(t)$.

c) Lastly, for the 12 adaptation states (W_i: i = 1–12) we used Hebbian learning principle defined by the following combination function:

$$\mathbf{hebb}_{\mu}(V_1, V_2, W) = V_1 V_2 (1 - W) + \mu W$$

Numerically, a reified-network-architecture-based model is represented as follows [8]:

1. At every time point t, the activation level of state Y at time t is represented by $Y(t)$, with the values between [0, 1].
2. The single impact of state X on state Y at time t is represented by $\mathbf{impact}_{X,Y}(t) = \omega_{X,Y}\, X(t)$; where $\omega_{X,Y}$ is the weight of connection $X \rightarrow Y$.

3. Special states are used to model network adaptation based on the notion of network reification, which means that network characteristic are represented by network states. For example, state $\mathbf{W}_{X,Y}$ represents an adaptive connection weight $\omega_{X,Y}(t)$ for the connection $X \rightarrow Y$, while $\mathbf{H}_Y$ represents an adaptive speed factor $\eta_Y(t)$ of state Y. Similarly, $\mathbf{C}_{i,Y}$ and $\mathbf{P}_{i,j,Y}$ represent adaptive combination functions $c_Y(.., t)$ over time and its parameters respectively. Combination functions are built as a weighted average from a number of basic combination functions $\text{bcf}_i(..)$, which take parameters $P_{i,j,Y}$ and values V_i as arguments. The universal combination function $\mathbf{c}^*_Y(..)$ for any state Y is defined as:

$$\mathbf{c}*_Y(S, C_1, \ldots, C_m, P_{1,1}, P_{2,1}, \ldots, P_{1,m}, P_{2,m}, V_1, \ldots, V_k, W_1, \ldots, W_k, W) = W + S[C_1\text{bcf}_1(P_{1,1}, P_{2,1}, W_1V_1, \ldots, W_kV_k) + \ldots + C_m\text{bcf}_m(P_{1,m}, P_{2,m}, W_1V_1, \ldots, W_kV_k)]/(C_1 + \ldots + C_m) - W]$$

where at time t:

- variable S is used for the speed factor reification $\mathbf{H}_Y(t)$
- variable C_i for the combination function weight reification $\mathbf{C}_{i,Y}(t)$
- variable $P_{i,j}$ for the combination function parameter reification $\mathbf{P}_{i,j,Y}(t)$
- variable V_i for the state value $X_i(t)$ of base state X_i
- variable W_i for the connection weight reification $\mathrm{W}_{X_i,Y}(t)$
- variable W for the state value $Y(t)$ of base state Y.

4. Based on the above universal combination function, the effect on any state Y after time Δt is computed by the following *universal difference equation* as:

$$Y(t + \Delta t) = Y(t) + [\mathbf{c}*_Y(\mathbf{H}_Y(t), \mathbf{C}_{1,Y}(t), \ldots, \mathbf{C}_{m,Y}(t), \mathbf{P}_{1,1}(t), \mathbf{P}_{2,1}(t), \ldots, \mathbf{P}_{1,m}(t), \mathbf{P}_{2,m}(t), X_1(t), \ldots, X_k(t), \mathbf{W}_{X_1,Y}(t), \ldots, \mathbf{W}_{X_k,Y}(t), Y(t)) - Y(t)]\Delta t$$

which also can be written as a *universal differential equation*:

$$\mathbf{d}Y(t)/\mathbf{d}t = \mathbf{c}*_Y(\mathbf{H}_Y(t), \mathbf{C}_{1,Y}(t), \ldots, \mathbf{C}_{m,Y}(t), \mathbf{P}_{1,1}(t), \mathbf{P}_{2,1}(t), \ldots, \mathbf{P}_{1,m}(t), \mathbf{P}_{2,m}(t), X_1(t), \ldots, X_k(t), \mathbf{W}_{X_1,Y}(t), \ldots, \mathbf{W}_{X_k,Y}(t), Y(t)) - Y(t)$$

The dedicated software environment used was implemented in MATLAB, which takes input of the network characteristics represented by role matrices. A role matrix is a specification indicating the role played by each state. This involves the states of the base models and the states related to plasticity and meta-plasticity and their roles along with the related parameters. Detailed information for the model can be found online [23].

4 Simulation Experiments

Simulation experiments offer insights in the model dynamics reflecting the human behavior. In this section we present how a narcissistic parent influences his/her child. Here, we have discussed only the scenarios, when a parent is happy, thus es_{happy} is high for the parent [6]. The simulation scenarios related to a child are when he/she is a) exhibiting narcissism under parental influence, b) when he/she is learning not to be a narcissist, and c) exhibition of narcissism while using the social media.

4.1 A Child Displaying Influence of a Parent's Narcissism

This first scenario addresses a child which is not using social media, but gets parental influence. An simple example scenario can be: A parent is an actor on a TV-show; when a child is along his/her parent then he will also like to react in a duplicate/instructed manner, to make the parent happy.

Figure 2 shows the results of such a scenario, here es_{happy} (blue) acts as input to the child (gains value = 0.95 at time point t = 25) [6], and ws_s = 0, as the child is not using the social media. The respective sensory (ss_h) and representation (srs_h: mustard) activates after es_{happy}. This activates the belief state (cbs: purple dots) and cortex (cPFC: green) of the child at the same time $t \approx 11$. Reward related states (cstriatum: brown - bold and ces_{happy}: mustard - bold) starts to activate around t = 15 but stays till value = 0.55. At this moment the child's feeling related to self-reward are not active indicating that the child is just mimicking his/her parent without being influenced by his/her own feelings. However, at time point $t > 280$, feelings of self-love (cfs_{love}: red) and self-rewarding (cfs_{reward}: brightgreen) start to increase due to activation in the insula (cinsula: magenta) at time point t = 250. This leads to reflect the narcissistic behavior (through social contagion), by increasing cstriatum and ces_{happy} to value = 1 at time point t = 300. This is also reflected by an increase in cbs at $t \approx 280$, indicating the learning of self-view or belief (cbs).

Here, the dotted lines show the dynamics of the involved W-states (i.e.: W_2, W_3, W_4, W_5 and W_6), indicating the hebbian learning effect through the involved states of the base model. It can be seen that learning for the self-rewarding states starts at time point $t > 50$ shown by W_4, which leads W_5 and W_6 to learn around time point t ≈ 280 and the child is able to learn this contagion behavior around time point $t > 300$. Here it can be noted that W_2 and W_3 also reflect this at $t \approx 280$ thus reflecting learning of connections cbs $\rightarrow$ cfs_{love} and $cfs_{love} \rightarrow$ cbs (at Level I). This behavior indicate that the child has learnt how to act in a social environment.

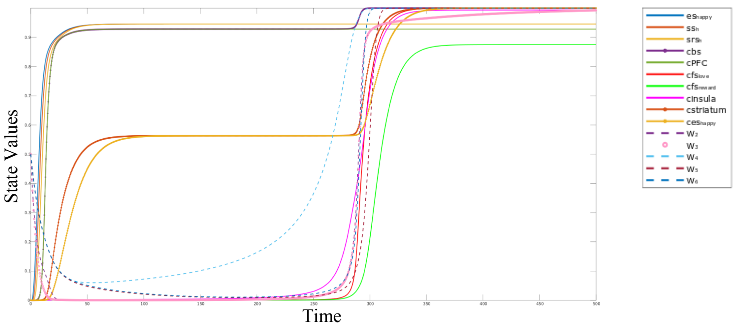

Fig. 2. Child replicating his parent's narcissism (es_{happy} = 1)

4.2 Influence of Age Over Narcissism

In this second scenario, with the passage of time (age) the child notices that his parent is a narcissist and he chooses for him/herself not to be a narcissist. An example can be that the child is in a social gathering along with his/her parent but prefers to sit at a calm/unnoticed place, rather than replicating the parent's behavior. So, while the parent is exhibiting his grandiosity, the child prefers to remain unnoticed.

Figure 3 shows such a scenario, the child gets the stimulus (es_{happy} = 0.95 at time point < 25) while not using the social media ws_s = 0. He/she starts to learn through hebbian learning that (s)he should not replicate his/her parent. This evaluation is shown by the corresponding evaluation state ($eval_h$: purple), which is activated around time point t = 20, after the sensory (ss_s: brown) and representation state (srs_s: mustard). It further activates the states of action with personal satisfaction in the duration of t = 50–150 (cps_{act}: green, fs_{sat}: blue, hipp: brown and ces_{act} : light blue).

Here, dotted states show the W-states of the model. It can be seen that the learning starts at time point t ≈ 25 with his/her age (W_1) and helps W_7 and W_8 to learn by t = 100. This indicates that the child is able to learn by his experience till time point t = 200 which is also reflected in his behavior/action (ces_{act}). Here, it is interesting to notice the behavior of W_1 and W_8, at first he/she un-learns the feeling of satisfaction and evaluation regarding the grandiosity of parent, by using his memories (hipp), which doesn't drop over the time and, the experiences are earned by the action (W_1 and W_8).

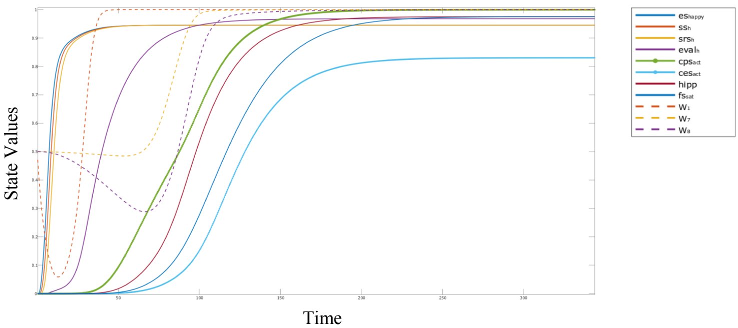

Fig. 3. Child learns to be non-narcissistic (es_{happy} = 1)

4.3 Child Using Social Media

In this section, we address the dynamics of the adaptive network model, when a child uses social media (like WhatsApp/Twitter). This is shown in episodes a) when a child is not using the social media and b) when child is using the social media (Fig. 4). Initially, when a child doesn't use social media at all and, (s)he is under the influence of a parent (es_{happy} = 1), the self-rewarding states are already active (bold curves - cstriautm: purple; ces_{happy}: green; cinsula: cyan) before time point t = 60.

The new episode starts at t = 60, when (s)he starts using social media i.e. ws_s = 1 (shaded region). This activates the corresponding sensory (ss_s) and representation (srs_s) states. After some time, the control state (ccs: purple) and evaluation state ($eval_s$:green) activate and increases the preparation (ps_{share}: magenta) and execution states (es_{share}: red). The three associated feelings: novelty (fs_{nov}: brown dotted), urge (fs_{urge}: blue dotted) and emotion (fs_{em}: light blue) associated to the content, tends to grow by every episode along with the experience (exp). An example of experience can be, the number of likes or comments obtained from others over certain content. Here, the self-rewarding states are alleviated during sharing of the content, indicating that sharing gives him/her narcissistic pleasure. The suppression of self-rewarding states between t = 120–180, indicate that the child enjoys self-exhibiting on social media with parental influence. However, once narcissistic pleasure reaches a maximum (value = 1), the self-rewarding states stay high, indicating that (s)he is always looking for reward and attention or love.

In Fig. 5, it can be seen that W-states related to self-rewarding behavior (W_i: i = 2–6) continue to learn with each episode of sharing the content over the social media till t = 250. This shows that the narcissistic instinct of the child is fulfilled by sharing any content over social media. The W-states related to sharing the content over social media (W_i: i = 9–12) slowly increase with time, and after t > 450, they reach their maximum values. This indicates that the child has learnt about sharing from his/her experiences in each episode. It would be interesting to see behavior of $W_{12}(W_{urge,psshare})$, as it shows that the urge of sharing content is almost new at the start of each episode (/exposure to social media) till he is a regular user of social media.

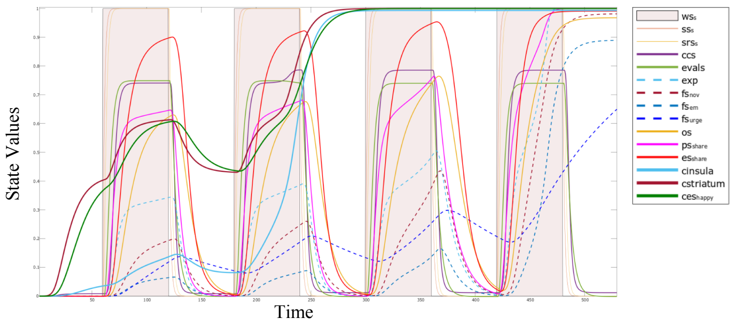

Fig. 4. Child sharing and self-rewarding states are active (es_{happy} = ws_s = 1)

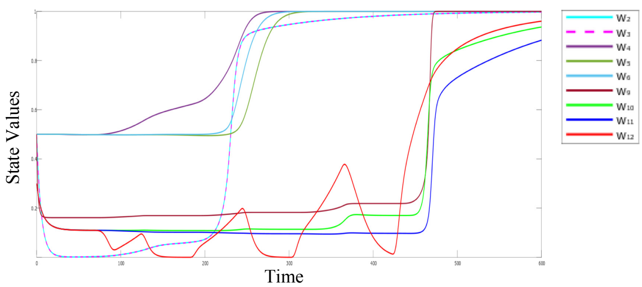

Fig. 5. W states while child is sharing and self-rewarding states are active (es_{happy} = 1; ws_s = 1)

5 Conclusion

Our work aims to explore computationally how a child can be influenced by her or his parent's narcissism through a second-order adaptive network model. The model was designed based upon social, cognitive and psychological literature. Three simulations were presented. First we showed a) how a child mimics his/her parent grandiosity, then we showed b) how she or he learns to act in a non-narcissist way based upon experience. We also explored c) how a child decides what she or he should share over social media and how this influences his behavior.

As a future work, we would like to collect and use empirical data related to our model, to verify the behavior of the model with real-world data.

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